Attachment 1: Excerpt from Heal the Bay's 2007 Malibu Creek Watershed Final Grant Report

Chlorophyll-a Sampling:
Chlorophyll-a content from the water provides a measure of plant material (in this case algae) in the water column because it is ubiquitous in all photosynthetic organisms. Algae samples were collected with a modified 60 cc syringe (see below) for chlorophyll-a analysis from three transect positions (10%, 50% and 90% of stream width). Samples were stored in an amber bottle to minimize degradation from sunlight and immediately frozen on dry ice.

The 60 cc syringe was used to excise replicable cylinders of known diameter (2.6 cm) through the water column to collect both floating and attached algae. The tapered end of the syringe was cut off, and circular scouring disks were fixed to the plunger with Velcro. To collect a benthic sample, we placed the syringe barrel on the target substrate, and pushed the scouring pad through the syringe. The end of the plunger was then rotated 10 times clockwise and 10 times counter-clockwise to scrub off and trap all *Periphyton* within the bounds of the syringe. Individual scouring pads (with benthic algal samples) were then stored on dry ice. Any remaining macroalgae attached to the substratum within the sampled area were collected with a forceps. A maximum of 6 individual samples (3 floating and 3 attached) per transect were collected, depending on presence/absence of algae in that position.

Chlorophyll-a was passively extracted from each sample using 30 mL 100% laboratory grade acetone at 4º C for 24 hr (Appendix IV). Multiple samples per transect were pooled with proportional amounts of acetone added to the slurry. Mean chlorophyll-a content per site (floating and benthic algae combined) was determined using the Heλios-α multiple beam spectrophotometer (Thermo Electron Corporation, Waltham, MA). Those means were then summed for the three transects for chlorophyll-a content per cubic meter at each site.

Chlorophyll-a Results:
Heal the Bay did extensive research in selecting both the field collection protocol and laboratory protocol for chlorophyll-a. The field collection protocol was adapted from a similar protocol developed by the Southern California Coastal waters Research Project (SCCWRP). Two important considerations in developing the field collection protocol was the ability for citizen volunteers to be able to collect samples (while supervised by professional staff) and to minimize any bias. To accomplish these objectives we chose to collect samples from only hard substrates (no soft substrates such as sand and fine sediments). The Stream Team collects samples from floating algae and attached or benthic algae from hard substrates (Appendix IV). The laboratory procedure was developed in collaboration with Julie Simpson, PhD (Department of Ecology, Evolution, and Marine Biology, UC Santa Barbara), and is a modification of Elizabeth J. Arar, 1997 (NERL-EPA 446.0; Appendix IV). This method was selected because it details quality assurance/quality control procedures for the laboratory and utilizes an equation developed by Lorenzen to correct the chlorophyll-a values by removing pheo-pigment interferences.

We followed guidelines in *Survey of Nutrients in the Malibu creek Watershed* (Busse et al. 2003, SCCWRP technical report #412), which proposed chlorophyll-a impairment levels. Dodds et al. (1998) suggested a classification system for trophic status of streams based on mean benthic chlorophyll a values from many studies. According to this classification scheme, mean benthic chlorophyll-a values <20 mg m^{-2} indicate low dissolved nutrients result in sparse algal growth, 20 - 70 mg m^{-2} indicate a mesotrophic system, and >70 mg m^{-2} lead to eutrophication (large algal blooms and ultimately depleted oxygen levels). Dodds and Welch (2000) proposed that individual maximum benthic chlorophyll-a measurements should not exceed 200 mg m^{-2} to maintain the aesthetic and recreational values of streams. However, maximum benthic chlorophyll-a concentrations of 100 mg m^{-2} were recommended by Welch et al. (1988), Horner et al. (1983), and Nordin (1985). Because more researchers have suggested the lower value, we used 100 mg m^{-2} as the threshold for impairment in Malibu Creek.

Heal the Bay sampled chlorophyll-a over a six month period between December 2005 and May 2006. Samples were collected whenever algae or thick diatoms (> 5mm in thickness) were present at the sampling location. When comparing percent algae cover with chlorophyll-a assessment, the LA-RWQCB prefers direct water chemistry measures of chlorophyll-a as they feel this measure is more enforceable. In the following graphs of Chlorophyll-a content, please note that the scale of concentrations varies from site to site.

Site 1 was located at the Serra Retreat Bridge just above the City of Malibu boundary on Malibu Creek (Figure 4). Site 1 had more than 30% algal coverage in every month except January 2006 (Figure 18), In January the percent algal cover was just over 10% and the corresponding chlorophyll-a concentration was 0. In March the percent algae cover just exceeded the 30% limit and the chlorophyll-a measurement also just exceeded the 100 mg/m^2 proposed limit (Figure 18). Both measures yielded the same conclusion: site 1was impaired from algae.

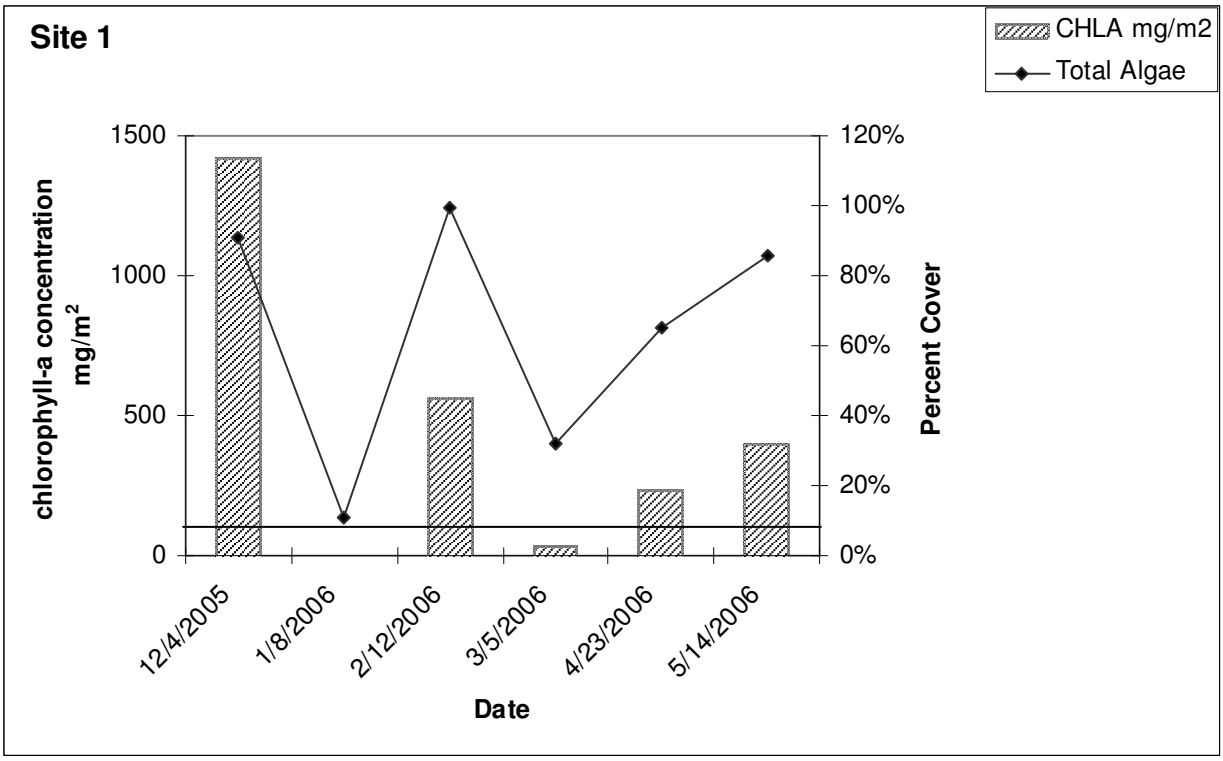

Figure 18. Chlorophyll-a concentration (bars) and percent algae cover (line) at site 1. The horizontal line represents the suggested impairment level of 100 mg/m^{2}chlorophyll-a.

Site 2 was located at the base of Cold Creek just before it drains into Malibu Creek (Figure 4). The Cold Creek outlet site was impaired with algae February-May 2006 (4 out of 6 samples). According to the chlorophyll-a data, site 2 was impaired in 5 out of 6 of the samples -- including December 2005 (Figure 19). The percent cover threshold is more conservative than the chlorophyll-a limits.

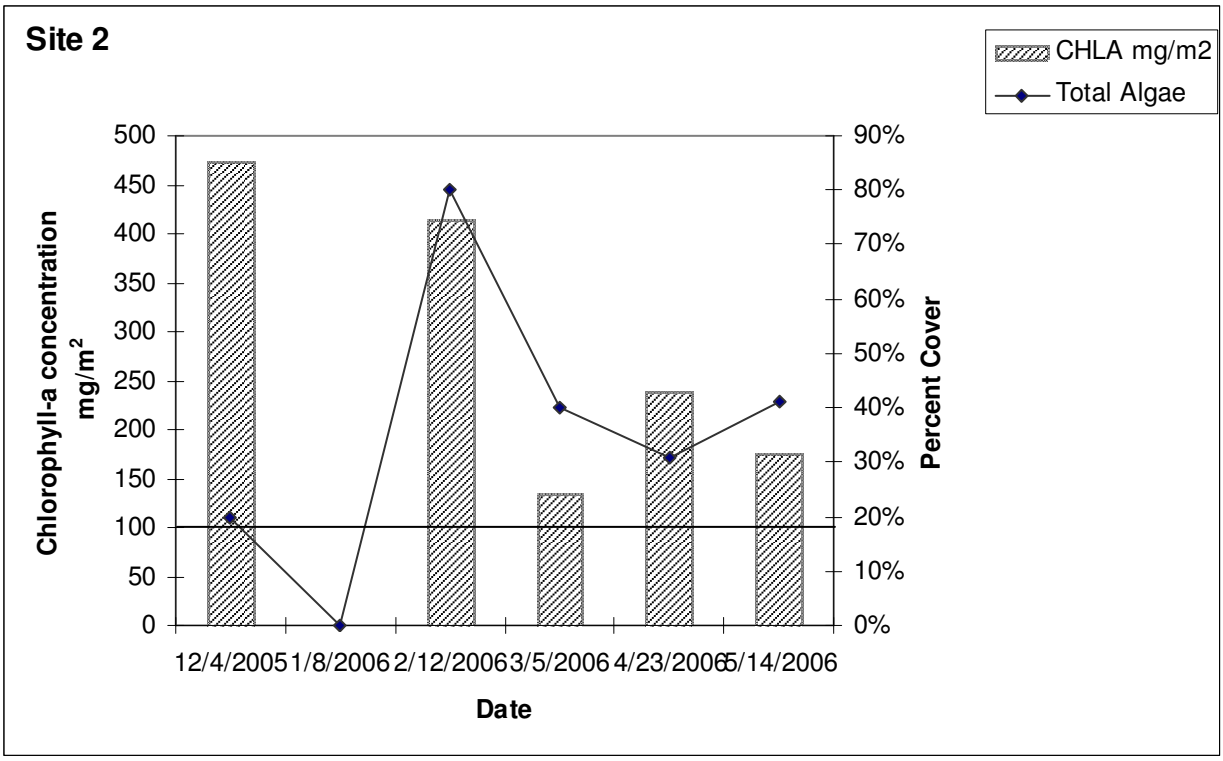

Figure 19. Chlorophyll-a concentration (bars) and percent algae cover (line) at site 2. The horizontal line represents the suggested impairment level of 100 mg/m^{2}chlorophyll-a.

Site 3 was at upper Cold Creek where it is minimally impacted by development (Figure 4). Between December 2005 and May 2006 site 3 never exceeded the impairment criteria for percent algal cover or for chlorophyll-a (data not shown).

Site 5 was the Las Virgenes Creek outlet site just upstream of the confluence with Malibu Creek (Figure 4). Site 5 exceeded both the percent algal cover and chlorophyll-a limits in December 2005 and February, April and May 2006 (Figure 20).

Site 7 was the Agoura Hills outlet site on Medea Creek into which runoff from the City of Agoura Hills flows (Figure 4). It is an urbanized area and is infested by the invasive New Zealand Mudsnail. Site 7 exceeded the percent algal cover limit twice in February and in May. The chlorophyll-a concentration was exceeded on four occasions (Figure 21). The trend for exceedances and near exceedances was similar for algae cover and chlorophyll-a, but the results suggest that the percent algal cover criterion is more conservative than the chlorophyll-a criterion. For example, in April 2006, algal cover was 28% yet the chlorophyll-a concentration was 215 mg m^{-2}, again demonstrating that the percent algal cover impairment threshold is more conservative than that for chlorophyll-a.

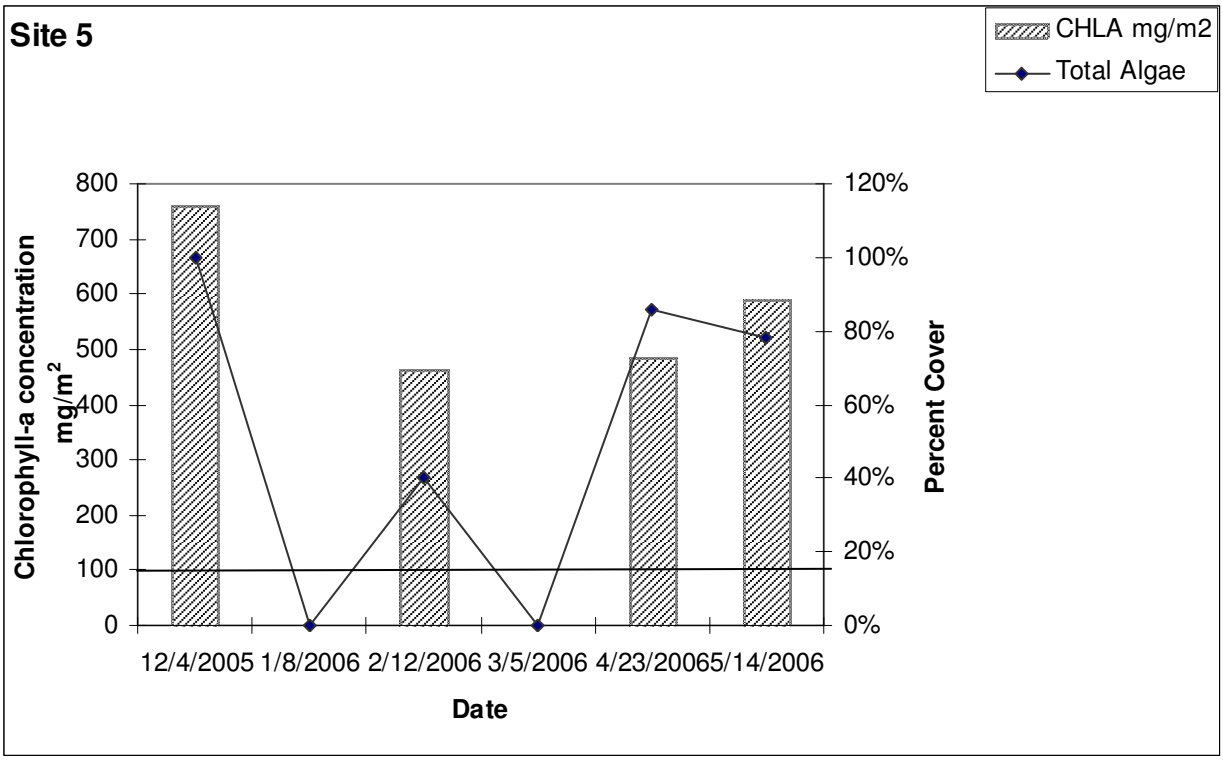

Figure 20. Chlorophyll-a concentration (bars) and percent algae cover (line) at site 5. The horizontal line represents the suggested impairment level of 100 mg/m^{2}chlorophyll-a.

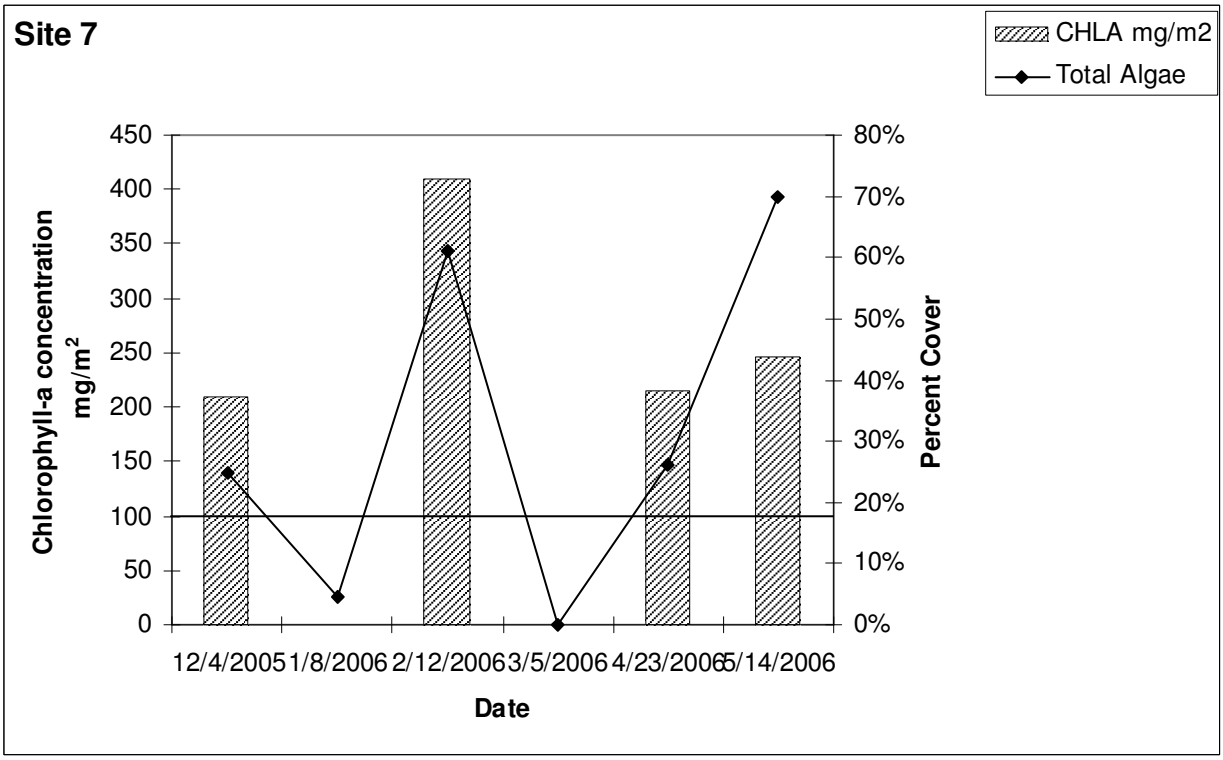

Figure 21. Chlorophyll-a concentration (bars) and percent algae cover (line) at site 7. The horizontal line represents the suggested impairment level of 100 mg/m^{2}chlorophyll-a.

Site 12 was the Rock Pool in Malibu Creek State park above the confluences of Cold Creek and Las Virgenes Creek on Malibu Creek (Figure 4). Site 12 exceeded the percent algal cover limit in 4 of the 6 samples. The chlorophyll-a concentration was exceeded on three occasions (Figure 22). The December sample showed 100% algal cover and only 72 mg m^{-2} chlorophyll-a concentration. Regardless of which impairment criteria limit is selected, site 12 would be considered impaired.

Site 13 was located in the middle of Las Virgenes Creek and receives runoff from a portion of the City of Calabasas (Figure 4). Site 13 exceeded the percent algal cover limit in December 2005. The chlorophyll-a concentration was exceeded in May 2006 (Figure 23). The May sample showed only a 5% algal cover, while chlorophyll-a concentration was nearly 800 mg m^{-2}. This again suggests that the percent algal cover threshold is more conservative than the chlorophyll-a limits.

Site 14 was located in Solstice Creek and receives nuisance runoff from National Park Service users and a small cluster of houses including a vineyard upstream (Figure 4). Site 14 never exceeded the percent algal cover limit yet exceeded the chlorophyll-a concentration limit twice in February and March 2006 (Figure 24). This again suggests that the chlorophyll-a threshold is less conservative than that of percent algal cover.

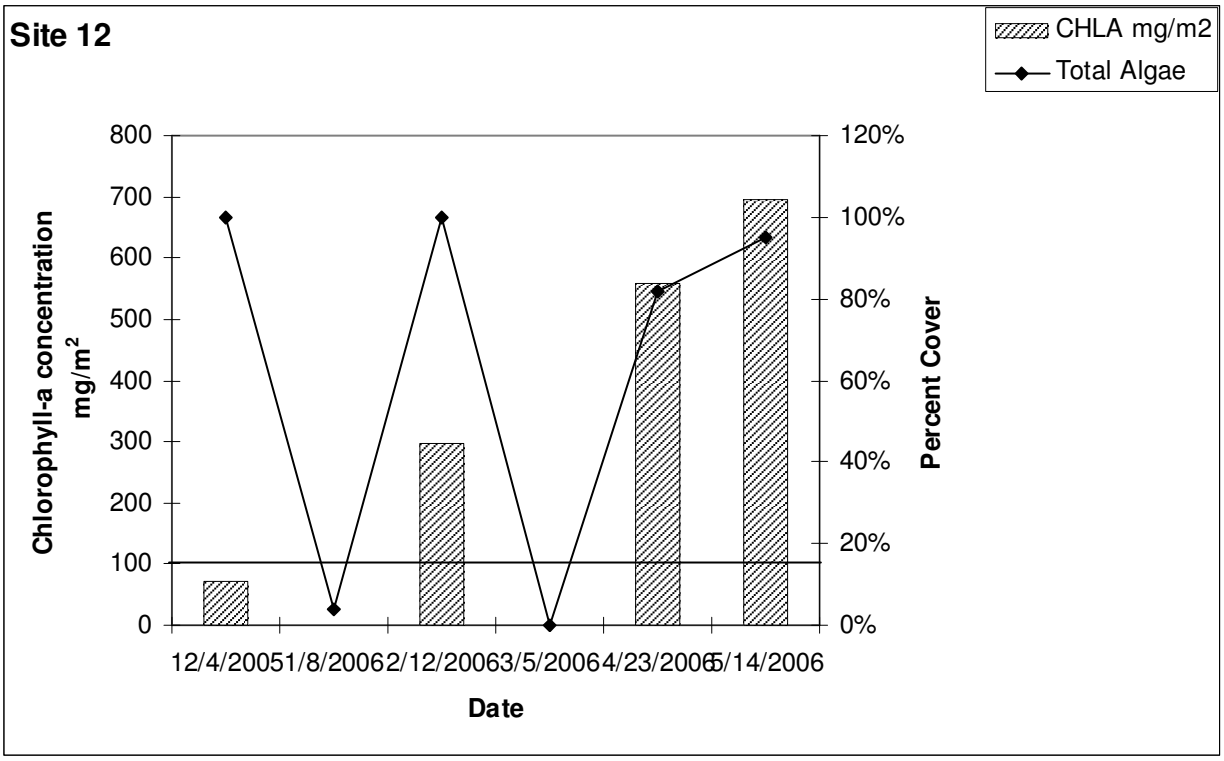

Figure 22. Chlorophyll-a concentration (bars) and percent algae cover (line) at site 12. The horizontal line represents the suggested impairment level of 100 mg/m^2chlorophyll-a.

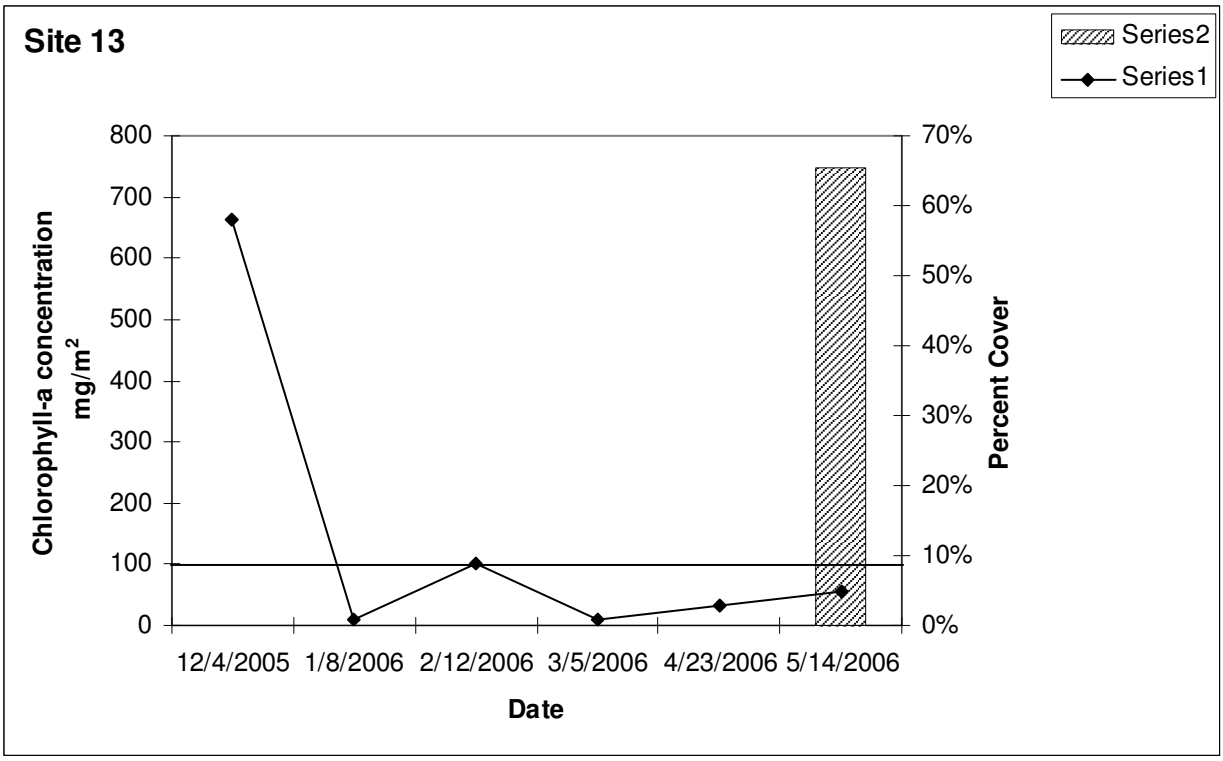

Figure 23. Chlorophyll-a concentration (bars) and percent algae cover (line) at site 13. The horizontal line represents the suggested impairment level of 100 mg/m^{2}chlorophyll-a.

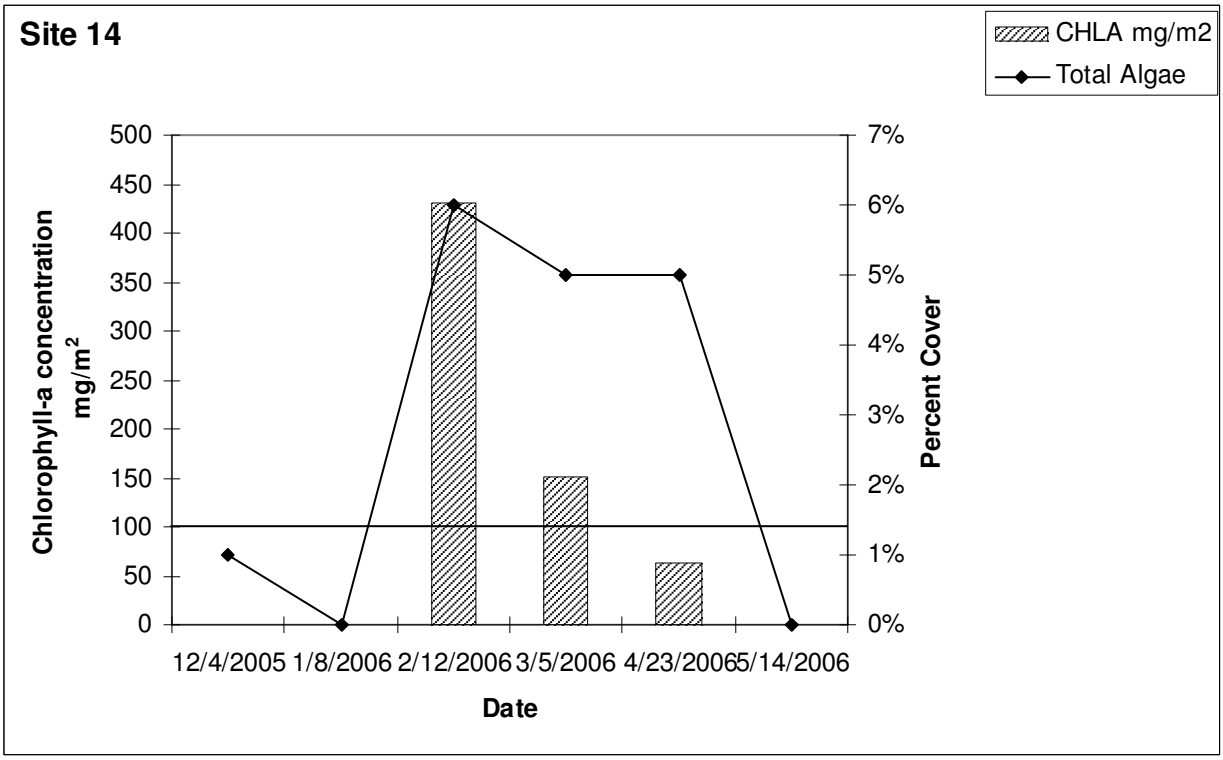

Figure 24. Chlorophyll-a concentration (bars) and percent algae cover (line) at site 14. The horizontal line represents the suggested impairment level of 100 mg/m^{2}chlorophyll-a.

Site 17 was located on Triunfo Creek upstream of Peter Straus Ranch. Site 17 receives runoff from rural residential property, vineyards, and horse facilities in Triunfo and Lobo Canyons (Figure 4). Site 17 exceeded the algal cover threshold on three occasions and the chlorophyll-a concentration limit on four occasions (Figure 25). This again suggests that chlorophyll-a threshold is less conservative than that for percent algal cover. It is worth mentioning that according to the chlorophyll-a threshold, when algae were present, the stream was impaired.

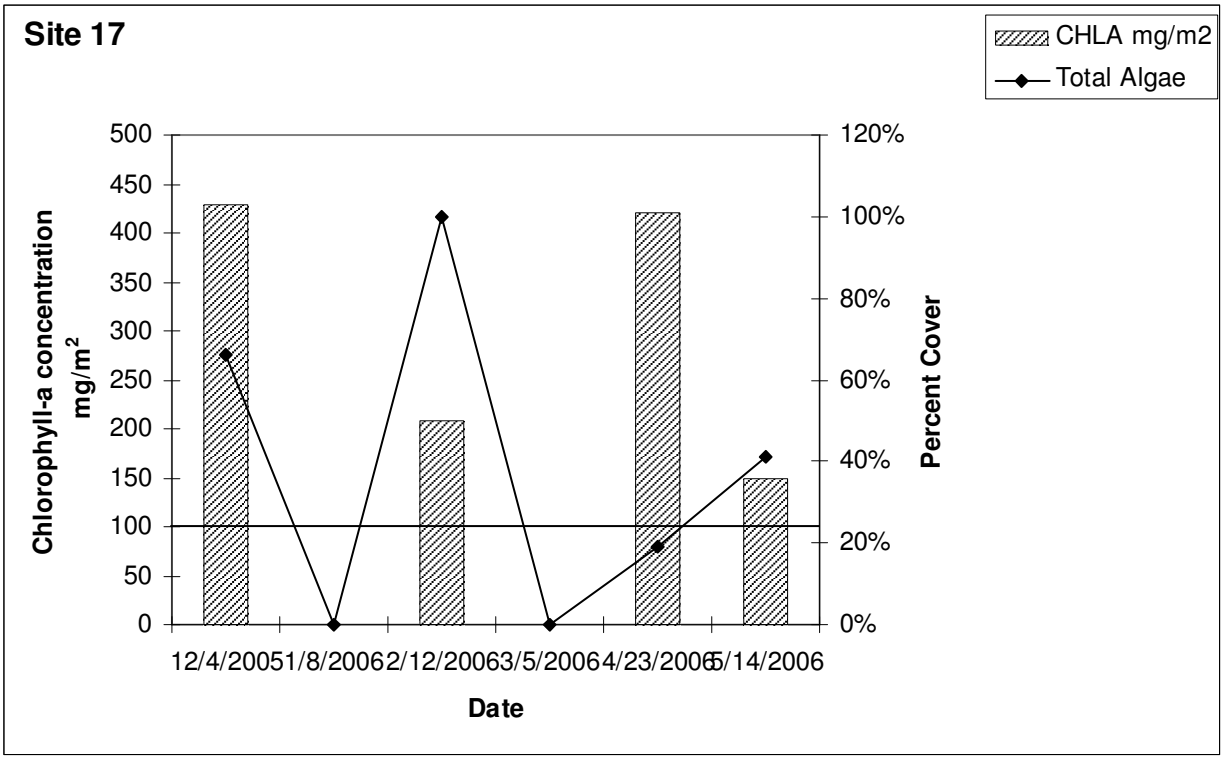

Figure 25. Chlorophyll-a concentration (bars) and percent algae cover (line) at site 17. The horizontal line represents the suggested impairment level of 100 mg/m^{2}chlorophyll-a.

Site 18 is located at the downstream end of Lachusa Creek in eastern Malibu just upstream of Pacific Coast highway. The Lachusa Creek site receives runoff from rural residential land uses and open space (Figure 4). Site 18 never exceeded the percent algal cover limit and yet did exceed the chlorophyll-a concentration limit on three occasions (Figure 26). This again demonstrates that the chlorophyll-a exceedance threshold is less conservative than that for percent algal cover. It is worth mentioning that the chlorophyll-a limits were more than double the highest proposed chlorophyll-a concentration limits from the literature.

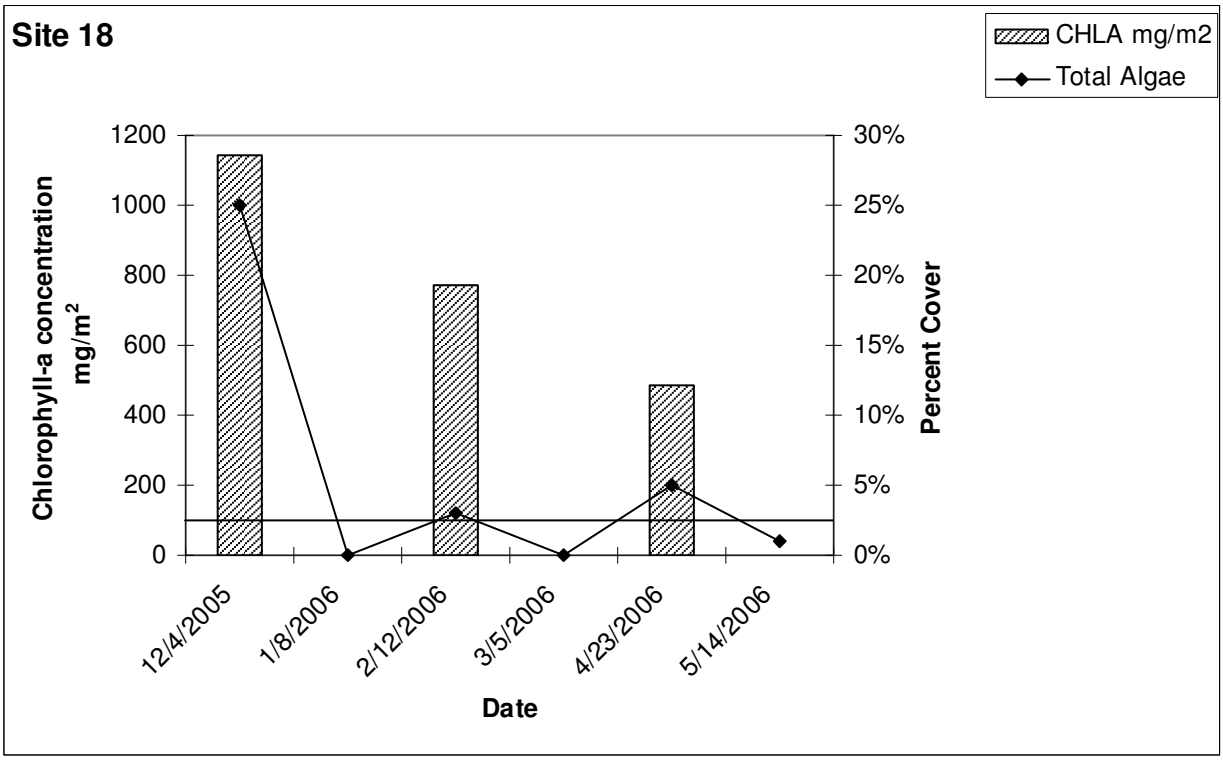

Figure 26. Chlorophyll-a concentration (bars) and percent algae cover (line) at site 18. The horizontal line represents the suggested impairment level of 100 mg/m^{2}chlorophyll-a.

Algae Project Success and Recommendations:

Heal the Bay suggessfully identified and implemented chlorophyll-a sampling and analysis methods that were readily adopted by our volunteers, and can be readily adopted by other monitoring groups. In general, algal cover tracks chlorophyll-a concentration data. However, using the chlorophyll-a concentration threshold of 100 mg $^{-2}$ is more protective of water quality than using the algal cover threshold.

Among the objectives for the algae measurement portion of the grant was to establish whether or not algae impairment only occurred during the summer. To address this question the Stream Team conducted winter algae percent cover mapping on three streams in the Santa Monica Mountains. Additionally, we reviewed previously mapped percent algae coverage data collected in the winter months between 16 November and 15 April from 2001 and from 2003-2004 on Malibu Creek. The data clearly demonstrated that more than 50% of the entire stream length was impaired by algae.. The analyses previously discussed in this document and the website algae data (http://www.healthebay.org/streamteam/data/chem/query/) clearly demonstrate that algal impairment exists year round in the watershed.

The analyses that compare percent algal coverage to nutrient concentrations clearly show that nitrate+nitrite-nitrogen and/or orthophosphate concentrations that exceed the 0.10

mg/l Heal the Bay thresholds will cause algal impairment. We recommend that the EPA and the LA-RWQCB set the total maximum daily load limits at 0.10 mg/l for both nitrate-nitrogen and orthophosphate. If these threshold limits are not set it is unlikely that algal impairments will ever be addressed. Further, the chlorophyll-a analyses demonstrate that using chlorophyll-a concentrations to establish algal impairment is more protective than the existing impairment criteria of 30% stream cover 10% of the time. Heal the Bay recommends that the chlorophyll-a concentrations be accepted as another criterion to determine algal impairment.